International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 17-03-2022, Accepted: 03-04-2022, Published: 18-04-2022
Volume 7, Issue 4, 2022, Page No. 128-129

Role of non-biting midges (Diptera: Chironomidae) as biomonitoring agents

Uttaran Majumdar
Department of Zoology, Hooghly Women's College, Hooghly, West Bengal, India

Abstract
Chironomids are cosmopolitan, diverse aquatic insects of freshwater systems. Bioindicators provides information about ecosystems that are very sensitive to pollutants in the environment. Their morphology, physiology and behavior are affected by the concentration of certain pollutants or it may die. Polytene chromosomes of these midges may be used as biomarkers for heavy metal pollution. Aberrations in polytene chromosomes correlate with degree of pollution stress and express diverse response to toxic agents.

Keywords: bioindicators, chironomids, deformities, polytene chromosomes, pollution

Introduction

Members of the family Chironomidae (Diptera) are often called blind mosquitoes and non-biting midges. They show close affinities towards families Ceratopogonidae and Culicidae (Armitage *et al*, 1995) [1]. Ferrington *et al*, 2008 reported the existence of nearly 5000 species throughout the world. The larvae of non-biting midges are benthic and sediment dweller (Oliver, 1971) [9]. Most of the larvae are red due to the presence of hemoglobin, that permits them to live in low oxygen concentrations and it may also help to metabolize xenobiotics. Chironomids are one of the most important sources of food for birds and fishes (Hudson *et al*, 1990) [5]. They act as a link in aquatic food webs between producers (benthic algae and phytoplanktons) and secondary consumers.

Bioindicators are the living organisms, which are used to assess the condition of the natural ecosystem. Chironomids are one of the most important bioindicators among aquatic insects. Furthermore, they are important to freshwater monitoring, protection, and conservation due to their response to adverse changes in environment (Barbosa *et al*, 2001) [2]. Chironomids are well known due to their potential role as biological indicators of environmental conditions and pollution stress (Pinder, 1986) [10].

Study of morphological changes as a biomonitoring tool

Larvae of non-biting midges are benthic, live at the bottom, where pollutants often accumulate. Generally, eutrophic water is inhabited by species eating organic meals and bottom deposits with the filtration method. These deposits are utilized by larvae during feeding and nest building; so they are constantly affected by pollutants. Larvae can metabolize these contaminants, but the end products may also influence morphological changes. Pollutants are accumulated in their tissues and these larvae act as a primary link in the food chain from sediment to humans through fishes and other aquatic animals. Antennal deformities also provide warning for the presence of toxic pollutants in the aquatic environment (Warwick, 1990) [11]. Lenat (1993) [7] classified the deformities in mentum into three groups:

Group 1: Very little deformities almost indistinguishable from normal one.
Group 2: More distinct deformities, like extra teeth, missing teeth, large gaps, and asymmetry.
Group 3: With three or more alterations from normal one.

Changes in polytene chromosome as a biomonitoring tool

Somatic cells of larvae of non-biting midges are very responsive to the effects of contaminants in aquatic environment. Nucleolar organizer (NOR) and Balbiani rings (BR) are considered as models for this purpose (Hudson & Ciborowski, 1996) [4]. Structural and functional changes of the polytene chromosomes of salivary glands show responses to the pollutants. Functional alterations occur in several ways, like decrease in puffing activity of NOR and BRs, appearance of new puffs, decondensation of telomeres and centromeres along with synapses in both the homologues. Balbiani rings are related to genes that encode silk proteins of high-molecular-weight that are required to build the tubes for themselves. Increased transcription in BRs, results into large puffs. Treatment with various concentrations of ethanol, galactose and cyclohexamide lead to decreases in the level of transcription. NORs are sites of high transcription where rRNA genes are found in higher number that are essential for cellular maintenance (Hudson & Ciborowski, 1996) [4]. The intensity of transcription is related to protein requirements of the cells. The most frequently encountered chromosome aberrations are deletions, inversions and amplifications. They are considered as one of the best marker of trace-material genotoxicity (Michailova *et al*, 2011) [8].

Metals like Zinc, Iron, Copper, Magnesium, Cobalt etc are required in trace amount for normal cellular functions as they form active sites for many enzymes. However, if physiological concentration exceeds, they are toxic to cells. They can cause both acute and chronic toxicity; leading to various types of disorders in hatching, growth, maturation and reproduction.

The biological approaches for assessing the impact of contaminants on environment have some advantages. They provide direct way to study the impact of contaminants. It also allows evaluation of contaminants at different levels of ecosystem. Chironomid larvae can be kept in controlled conditions in acute and chronic tests for detection of toxicity. Higher concentrations of trace metals affect the genome of chironomids. Genome instability was shown by inversions and tandem fusions that create novel combinations of genes and lead to micro evolutionary process of chironomids. Somatic structural and functional alterations result in decreasing the activity of NOR and BRs in salivary gland chromosomes of chironomids (Kiknadze *et al*, 2010). Detection of rearrangements in salivary gland chromosomes is considered as one of the most accepted bioassay techniques in freshwater ecosystem.

Conclusion

Mouth parts deformities in non-biting midge larvae have a relation with pollution. Changes in polytene chromosomes may be used as biomarkers for heavy metal pollution. They exhibit different degrees of response to toxic agents. Chironomid larvae are considered as a potential tool for the assessment of adverse effects of toxic agents at different levels of ecosystem.

References

1. Armitage PD, Cranston PS, Pinder LCV. The Chironomidae: Biology and ecology of non-biting midges. 1st ed., Chapman and Hall, 1995, 1-538.
2. Barbosa F, Galden N, Callisto M. Biodiversity assessment of benthic macroinvertebrates in altitudinal ecosystem of Serra do Cipo (MG Brazil). Brazilian Journal of Biology,2001:61(2):239-248.
3. Ferrington LC, Coffman WP, Berg MB. Chironomidae: An introduction to the aquatic insects of North America. Merritt RW, Cummins KW, Berg MB (Eds). Kendall and Hunt, 2008, 847-989.
4. Hudson LA, Cibrowski JH. Spatial and taxonomic variation incidence of mouth parts deformities in midge larvae (Diptera: Chironomidae: Chironomini). Can. J. Fish. Aquat. Sci.,1996:53:297-304.
5. Hudson PL, Lenat, DR, Caldwell, BA, Smith D. Chironomidae of the Southeastern United States: A checklist of species and notes on biology, distribution, and habitat. Fish and Wildlife Research,1990:7(4):1-4.
6. Kiknadze II, Istomina AG, Wulker WF and Vallenduuk HJ. The karyotype of Chironomus uliginosus Keyl. Becmhuk BOTUC,2010:14(1):22-28.
7. Lenat DR. Using mentum deformities of Chironomus larvae to evaluate the effects of toxicity and organic loading in streams. Journal of the North American Benthological Society,1993:12(3):265-269.
8. Michailova P, Szarek-Gwiazda E, Kownacki A & Warchalowska-Sliwa E. Biodiversity of Chironomidae (Diptera) and genome response to trace metals in the environment. Pesticides,2011:1-4:41-48.
9. Oliver DR. Life history of the Chironomidae. Annual Review of Entomology,1971:16:211-30.
10. Pinder LCV. Biology of freshwater Chironomidae. Ann. Rev. Ent.,1986:31:1-23.
11. Warwick WF. The use of Morphological Deformities in Chironomid Larvae (Diptera: Chironomidae) for Biological Effects Monitoring. Environ. Can. IWD Scientific Series No. 173, NHRI Paper No,1990:43:1-34.